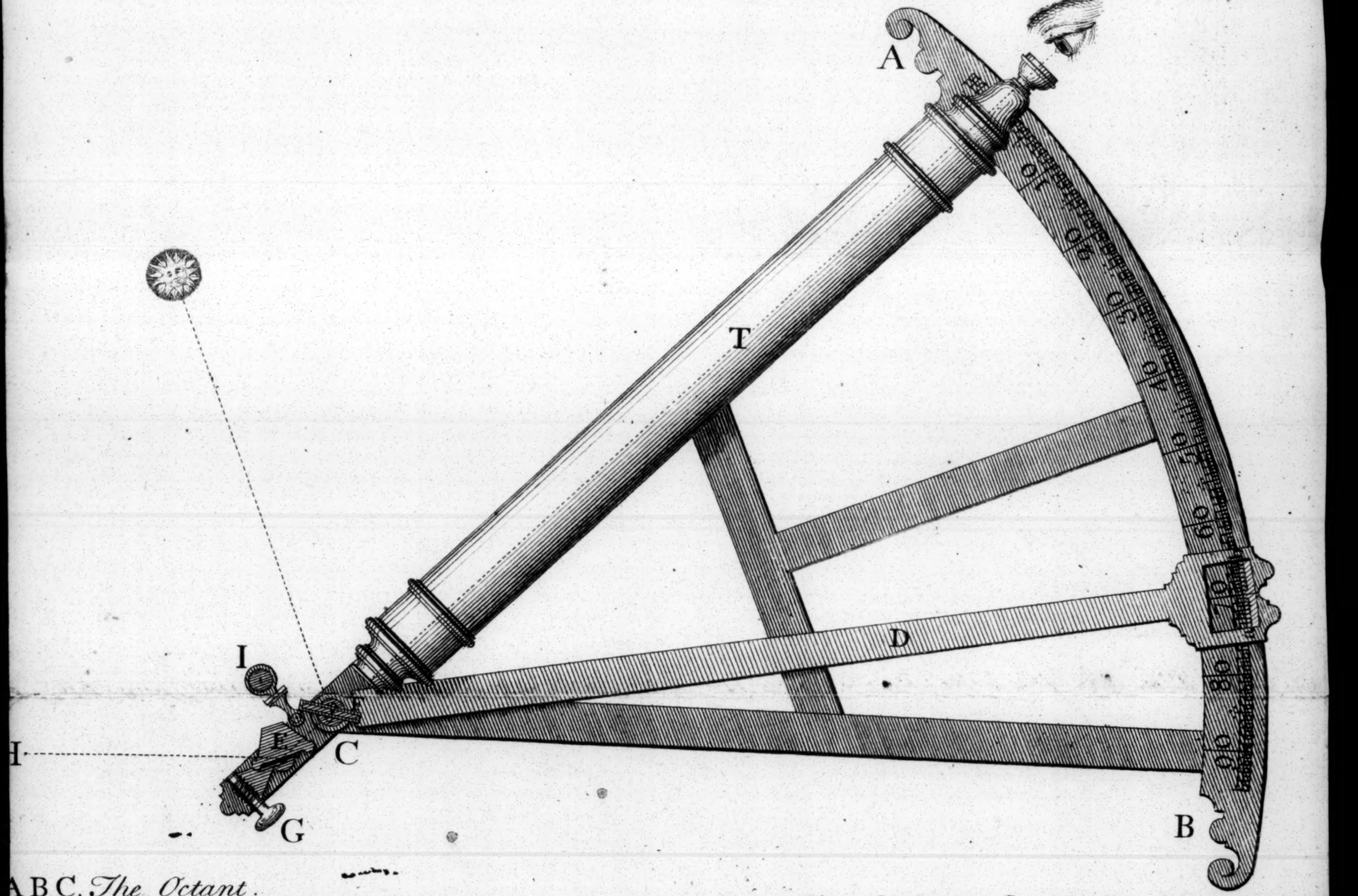
MR. SMITH'S NEW SEA-QUADRANT;

For taking Altitudes of the Sun, & Stars, without Interruption from the Ship's Motion: Tried at Sea, and approved by Captain Chriſtopher Middleton, Captain George Spurrel, Captain Joſeph Harriſon, and ſeveral other able and experienced Navigators.



ABC, *The Octant.*
AB. *The Arch graduated into Degrees & Parts of a Deg.*
D. *The Label or Index.*
a b, *The chamfer'd Edge of the Index; The Diviſions whereof are number'd to denote Minutes.*
E. *A Speculum or Priſm fix'd to the Octant.*
F. *A Speculum fix'd at the Center upon ye Index.*

I. *The red Glaſs to defend ye Eye from ye Sun.*
G, *The Adjuſting Screw.*
T, *The Teleſcope.*
✹, *The Sun, or Star.*
H, *A Point in the Horizon directly under the Object.*

To be had of the Inventor at his Office for Inſuring Ships &c. in Caſtle Alley facing the Weſt Entrance of the Royal Exchange, or at the Crown Coffee Houſe near Guildhall, London.

Price of the Inſtrument Two Guineas & an half.

Smeaton

THE DESCRIPTION, USE, and EXCELLENCY OF A NEW INSTRUMENT, OR SEA QUADRANT,

INVENTED BY

CALEB SMITH,

FOR

Taking Altitudes of the SUN, MOON, and STARS, from the VISIBLE HORIZON (as well as any other ANGULAR DISTANCES at Land or Sea) without Impediment or Interruption from the Ship's Motion;

WHEREBY THE

LATITUDE at SEA

May be obtained with greater *Certainty*, and more *frequently*, than by DAVIS's or any other of the *Common Inſtruments*. Tried, approved, and recommended by Capt. CHRISTOPHER MIDDLETON, Capt. GEORGE SPURREL, Capt. JOSEPH HARRISON, and ſeveral other able and experienced *Navigators*.

To which is added,

An ESSAY to make this *Quadrant* ſerviceable at *Sea*, as well as at *Land*, when there is NO HORIZON to be ſeen.

AS ALSO

The *Uſefulneſs* of its Application to an *Azimuth Compaſs* of a New Contrivance for diſcovering the *Variation* of the *Magnetic* NEEDLE, at Sea, *without* any *Aſtronomical Calculation*.

——— Si quid noviſti rectius iſtis,
Candidus imperti; ſi non, his utere ——— HOR.

To be had of the *INVENTOR*, at his OFFICE for Inſuring Ships and Merchandize, in *Caſtle-Alley*, over-againſt the Weſt Paſſage of the *Royal Exchange*; or at the *Crown Coffee-Houſe*, in *King-ſtreet*, near *Guildhall*, *London*.

The DESCRIPTION, USE, *and* ADVANTAGE *of Mr.* SMITH'*s* SEA-QUADRANT, *&c.*

AS *this Quadrant* has been ſometimes miſtaken for *another*, not unlike it in *Figure*, yet *different* in ſeveral Reſpects; it may be *proper*, for the Sake of Truth and Juſtice, to give ſome *Account* of ſuch OTHER INSTRUMENTS, as have *heretofore* been contrived for taking *Angles* by REFLECTION.

The *Firſt*, that I have heard of, was produced to the *Royal Society* in the Time of King *Charles* II. Its *Properties* are deſcribed by Biſhop *Sprat*, (in his *Hiſtory of that Society*, p. 296. §. 36. *Edit*. 4.) in the following Words: " *A new Inſtrument for taking Angles by Reflection; by which means the Eye at the ſame Time ſees the two Objects, both as touching in the ſame Point, though diſtant almoſt to a Semicircle; which is of great Uſe for making exact Obſervations at Sea.*" Our Hiſtorian has not mentioned the Inventor's *Name*; but I have been told it was of Dr. *Hook*'s Contrivance.

I have likewiſe ſeen an *old Inſtrument* for taking very *ſmall Angles*, ſuch as the *Appulſes* of the Moon to a fixed Star, by *Reflection*; it was ſaid to have been Mr. *Street*'s, the famous Author of *Aſtronomia Carolina*; he made uſe of two *plain Sights*, thro' which he looked at *one* Object *directly*, and the *other* was found by a *ſingle* Reflection from a Piece of plain *Looking-Glaſs*, quickſilver'd over on the Backſide.

Dr. *Halley*, when I firſt mention'd my *Method* of taking *Angles* at *Sea*, without any *double Reflection*, was pleaſed to tell me, that Sir *Iſaac Newton* and *himſelf* had contrived an *Inſtrument* for the ſame Purpoſe, wherewith *one* Object was obſerved by *direct Viſion*, and the *other* by a *ſingle Reflection* : By this they cou'd eaſily, and exactly, find the Quantity of any *Angle at Land*; but upon the leaſt *Motion* of the Inſtrument, the *two* Objects were found to *ſeparate* from each other, which made it *unſerviceable* at *Sea* : And this, no doubt, was the *Inconvenience* that attended *thoſe above-mentioned* ; otherwiſe their *Uſe* wou'd hardly have been *diſcontinued*.

Thoſe who firſt ſurmounted this *Difficulty*, were Mr. *Hadley* in *London*, and Mr. *Godfrey* in *Penſilvania*, by making uſe of a *double Reflection* for finding *one* Object, while the *other* was ſeen by a *direct View* ; it is ſomewhat ſurpriſing, that *both* theſe *Gentlemen*, tho' at a great *Diſtance*, had the good Fortune, *unknown* to each other, to hit upon this *uſeful* Invention, about one and the ſame time ; for it appear'd upon a careful *Examination* before the *Royal Society*, that Mr. *Logan*, Chief-Juſtice of the Province of *Penſilvania*, had tranſmitted an accurate *Deſcription* of Mr. *Godfrey*'s Inſtrument to *England*, before Mr. *Hadley*'s was publiſh'd in the *Philoſophical Tranſactions* ; and accordingly a *Minute* is made of this *Affair* in the Royal Society's Books. The original *Proofs*, or *Affidavits* that were made, in Mr. *Godfrey*'s Favour, remain in the Hands of Mr. *Peter Collinſon*, F. R. S.

About the *ſame* Time, or *before* this, (if I am rightly informed) Mr. *Hall*, an ingenious *Gentleman* of the *Temple*, invented an *Inſtrument* of the *like* Kind : But as it never was made *publick*, that I know of, I am not able to give any *particular* Deſcription of it.

The *Quadrant* we are now about to *deſcribe*, is *different* from any of the *former* ; each *Object* being *ſeen* by means of *one ſingle Reflection* ; it alſo removes the *Inconvenience* that attended Dr. *Halley*'s at *Sea* ; for the *Motion* of the *Ship*, or of the Obſerver's *Hand*, will never *interrupt*, or *diſturb* the Obſervation.

The

The Instrument conſiſts of an *Octant* A B C, (ſee the Figure) whoſe *Arch* A B, is accurately divided into *Ninety* equal Parts, anſwering (by its Conſtruction and the Nature of Reflection) to as many *whole Degrees*; whence, it is, *virtually*, or *in effect*, a Quadrant; *each* of theſe 90 *Parts* is again ſubdivided, into ſo many others as the Radius will allow without Confuſion, to denote Parts of a Degree; a *Label* or *Index* D turns upon a Pin in the Center, and marks the Diviſions graduated on the Arch; at or near its Center (as in the moſt convenient Situation) a ſmall *triangular Priſm*, or a *plain Speculum* E, is fix'd in Braſs-work, *perpendicular* to the Plane of the Inſtrument, ſo as to remain *immoveable* at the Time of Obſervation; and directly *upon* or *over* this, another *plain Speculum* F is faſten'd to the Index, in ſuch a manner, as to *move* or *turn* with it, upon the Center of the Arch. When the *Index* is placed at the *Beginning* of the *Diviſions*, (or ° Degrees) the *Baſes* of the two Priſms, or Speculums, muſt lie exactly in the *ſame Plane*, or in Planes *parallel* to each other; and for this Purpoſe, a ſmall *Screw* G is fix'd under one of the Speculums to *adjuſt* its Situation with reſpect to the other. Upon one of the Radii is placed a *Teleſcope* T with one Eye-Glaſs; or elſe a *Sight-Vane*; and a Piece of *dark plain Glaſs* I, to cover and obſcure that Priſm, or Speculum, from which the Sun's Rays are reflected, when he ſhines *too bright* for the naked Eye. If the Arch be continued to a Quadrant, and divided into 180 equal Parts, or Degrees; an Obſervation may be made therewith either forwards or backwards.

The *Graduation* of the Arch, from A to B, and Index at *a b*, is performed after the *manner* of *Nonius*; which, tho' much *preferable*, yet ſeems to be *leſs underſtood* (by Sea-faring Perſons eſpecially) than the common Diviſion by *Diagonal Lines*; for which Reaſon it may be proper to *explain* it here:

The *larger Spaces*, or *Diviſions*, on the Arch, as we ſaid before, expreſs *whole Degrees*, and the *ſmaller* denote *Parts* of a *Degree*; (for *Exam.* Half Ones;) on the *Chamfer'd Edge* of the Index, which ſlides along the Arch, a *Space* equal to 14 or 16 of theſe half Degrees, is taken, and accurately divided into 15 *equal Parts*; by which *Contrivance* the Scale is divided to every two Minutes; for it is manifeſt, that *one* of theſe Diviſions *on the Index* will, by this means *fall ſhort of*, or *exceed*, a Diviſion *on the Arch*, by $\frac{1}{15}$th of the laſt mentioned Diviſion; that is, by $\frac{1}{15}$th of half a Degree, or by two Minutes. And by a *like* Method it may be divided to every *Minute*, or leſs, if the Radius admit of ſo great an Accuracy without Confuſion. Now, the Degrees and half Degrees, of any Angle, are to be *counted* on the *Arch* itſelf; and the Minutes or remaining Parts, by the Subdiviſions on the *Index*, in the following manner:

1ſt, If the *Line* in the *Middle* of the Index, unite exactly, or *join with* any of the Diviſions on the Arch, ſo as to form a ſtrait Line, then it *ſhews*, by Inſpection, or at one View, the *Degrees* and *Parts of a Degree*, for *Ex.* the half Parts, contained in the Altitude, or Angle ſought. But,

2dly, If the *Middle Line* of the Index does *not* exactly unite or join with any of the Diviſions on the Arch; then *count* the Degrees, and Parts of a Degree, if there be any, contained between the ſaid *Middle Line*, and the *Beginning* of the Graduations on the Arch, or ° Degrees, and write them down, or keep them in mind.

3dly, Note carefully what *other Line*, or *Subdiviſion* on the Index *coincides*, or makes a *ſtrait Line*, with *ſome one* of the Diviſions on the Arch, and mark the *Number* anſwering thereto, which denotes ſo many *Minutes*.

4thly, Add the *Number* of *Minutes* thus found, to the *Degrees* and Parts of a Degree before ſet down, or reſerved

reſerved in Mind, (according to the ſecond Precept) and the *Sum* will give the *Altitude* or *Angle* ſought.

Leſt the *Glaſſes* by Accident ſhou'd happen to be *miſplaced*, or moved out of their *due Situation*, it is neceſſary at Sea, TO RECTIFY THE QUADRANT, before Obſervation, in the following manner:

1*ſt*, Fix the *Index* at the *Beginning* of the Graduations on the Arch, or 0 *Degrees*, and holding the *Quadrant* as upright as may be,

2*dly*, Place the *Teleſcope* or *Sight-Vane* to the Eye, and obſerve carefully the Line of the *Sea's Edge*, (which is to be taken for the *Horizon*) or any other diſtant *Object*, as the Sun, Moon, or a fix'd Star, ſeen by *Reflection* from one Speculum; and if it *coincide* exactly with the ſame *Line*, or *Object*, ſeen alſo by *Reflection* from the *other* Speculum; that is, if only *one* Horizon, or *one* Object appear; then the *Quadrant* is *rectified* already, and the Glaſſes need *no* further *Adjuſtment*: But if there appear *two* different Horizons, or *two* Images of the *ſame* Object,

3*dly*, Turn the *adjuſting Screw*, 'till the *two* Horizons be brought to *unite*, and appear as *one Line*; or 'till the *two* Images of the Object *coincide* and become *one*; for then the Speculums are truly *adjuſted*, and the *Quadrant rectified*, or fitted for *Obſervation*. *Which was to be done.*

The principal USE of this INSTRUMENT is, TO FIND THE ALTITUDE OF THE SUN, OR ANY STAR, AT SEA, with Eaſe and Exactneſs; which is thus perform'd;

1*ſt*, Let the Obſerver turn his *Face*, and alſo the *Quadrant*, directly *towards* the Sun, or Star to be obſerved; and hold it, as upright as he can, in the Vertical Circle or Plane that paſſes thro' the Object: (interpoſing the dark-colour'd Glaſs between the Sun and the Speculum that reflects his Rays, if he ſhines too bright) and here note, the croſs *Hairs* in the Teleſcope will *aſſiſt* very much in *judg-*

ing, when the Inſtrument is *near* an upright Poſture;

2*dly*, Let him place the *Teleſcope*, or *Sight-Vane* to his Eye, and looking *firſt* for the *Horizon*, or Line of the *Sea's Edge*, move the *Index* gently along the Arch, 'till the *Image* of the Sun, or Star, *appear* to be brought down ſo as to *touch* the ſaid *Horizon*; or ſeem to *lie exactly* level and cloſe to the *Edge of the Sea*; and then,

3*dly*, Stop the *Label* or *Index*; for the *Degrees* and *Minutes*, mark'd thereby, will ſhew the *Altitude* of the *Sun*, or *Star*, above the *viſible* Horizon. *Which was required.*

If the *plain Sight* is uſed, let the Obſerver take care that his *Hat* does not hang *over* the Glaſſes; for that will *hinder* the Sun from being ſeen.

Here it is alſo to be noted, that all *Objects* appear *inverted* or *upſide down*, if the plain Sight or Sight-Vane be uſed *inſtead* of the Teleſcope. In *this Caſe*, therefore, if the *Height* of the Sun's *apparent lower Limb* be taken, 16 *Minutes* muſt be *ſubtracted* for the Sun's *Semi-Diameter*, from the *Degrees and Minutes* ſhewn by the Index; and *added* when the *apparent upper Limb* or *Edge* is uſed, in order to obtain the *Altitude* of the *Sun's Center*. But all *Objects* are *erect* (tho' inverted as to Right or Left) when a *Teleſcope* is applied; wherefore 16 *Minutes added* to the *Height* of the lower Limb, or *taken* from the *Altitude* of the upper one, gives the true *Height* of the Sun's *Center*.

To find the Latitude at Sea; an Obſervation muſt be *made*, and frequently *repeated*, before the Sun, or Star come to the *Meridian*; in order to obtain its *greateſt* Height, or *Meridian* Altitude; by which, and the *Declination* of the *Sun*, or *Star*, taken out of the *Tables*, the LATITUDE may be readily *found* according to the common *Rules* deliver'd in every *Treatiſe of Navigation*.

It

It ſhould alſo be obſerved, that when *Altitudes* are taken from the *viſible Horizon* by this, or any other Inſtrument; if great *Exactneſs* be required, a proper *Allowance* ought to be made for the *Refraction* of the Atmoſphere; and alſo for the *Elevation* or *Height* of the Obſerver's Eye, above the Surface of the Sea, according to the following Tables.

Mr. FLAMSTEAD's TABLE of REFRACTION, to be ſubtracted from the *Altitude*, and added to the *Zenith-Diſtance*, found by the Inſtrument.

Deg. Appt Alt.	Refrac.		Deg. Appt Alt.	Refrac.		Deg. Appt Alt.	Refrac.		Deg. Appt Alt.	Refrac.	
°	'	"	6	'	"	°	'	"	°	'	"
0	33	00	12	3	45	29	1	27	46	0	46
0½	26	38	13	3	29	30	1	23	47	0	45
1	23	22	14	3	13	31	1	20	48	0	44
1½	20	17	15	3	00	32	1	17	49	0	42
2	17	26	16	2	48	33	1	14	50	0	40
2½	15	15	17	2	38	34	1	11	51	0	39
3	13	23	18	2	29	35	1	09	52	0	38
3½	11	53	19	2	21	36	1	07	53	0	37
4	10	39	20	2	14	37	1	05	54	0	36
4½	9	38	21	2	07	38	1	02	55	0	34
5	8	48	22	2	01	39	1	00	60	0	29
6	7	26	23	1	55	40	0	58	65	0	24
7	6	25	24	1	50	41	0	56	70	0	19
8	5	37	25	1	45	42	0	54	75	0	14
9	5	02	26	1	40	43	0	52	80	0	09
10	4	33	27	1	36	44	0	50	85	0	04
11	4	06	28	1	31	45	0	48	90	0	00

A TABLE, ſhewing the *Depreſſion*, or *Dip* of the *viſible Horizon*, below the *true Horizontal Plane*, according to the ſeveral *Heights* (therein mentioned) of the Obſerver's Eye, above the Surface of the Sea; to be *ſubtracted* from the *Altitude* taken by the Inſtrument.

The Eye above the Surface of the Sea in *Feet*.	Viſible Horizon depreſſed in *Minutes*.
1	1
3	2
7	3
12	4
18	5
27	6
40	7

This *Inſtrument* is likewiſe of *great Uſe* in taking any *other Angular Diſtances* at Sea or Land; for if it be held in the *ſame* Plane with any *two Stars*, or other *Objects*, whoſe *Diſtance* is required; and its Index moved to and fro 'till *one* of thoſe *Objects* appear, by Reflection from the immoveable Speculum, or Priſm, to *coincide*, or lie in *one Right Line*, with the *other*, ſeen, at the ſame time, by Reflection from the moveable Speculum; then the *Angle* of *Inclination* between the *two Speculums*, (whoſe *Meaſure* is the *Arch* of the Octant intercepted between the *Beginning* of the Diviſions and the *Middle Line* on the Index) will be exactly equal to *half the Angular Diſtance* of the ſaid Objects; that is, a *whole Degree* of the Angle ſought, will be *meaſured* in all Caſes, by the Space of *half a Degree* upon the *Arch* of the Octant; the *Demonſtration* whereof depends on this eſtabliſhed *Principle* in *Opticks*, that the *Angle* of Reflection is always *equal* to the *Angle* of Incidence; as Mathematicians will readily perceive, without ſurther Explanation. And for this Reaſon the *Arch* itſelf is *graduated*, in ſuch a manner, as to expreſs *twice* the *Number* of *Degrees* really contained there-

therein, that the *Index* may *ſhew*, by Inſpection, the *Degrees* and *Minutes* of the *Angle* required.

Having given the Deſcription, and Uſe of this *Quadrant*, it may be proper to mention ſome of its *Excellencies*, and *Advantages* above the *common* Inſtruments.

And 1*ſt*, We can take *Altitudes* of the *Sun*, and *Stars*, at *Sea*, with greater *Eaſe* and *Expedition*, than by any other; for, the Motion of the Ship makes it *troubleſome* and *difficult* to uſe the *common* Quadrant, at *Sea*, as it continually *interrupts* and *diſturbs* the Obſervation, by *altering* the due *Poſture* of the Inſtrument, and *ſnatching* the Horizon, as well as the Shadow, made by the Vane, *out of Sight* on a ſudden; ſuffering them to return only by *Fits* as it were, and ſmall *Intervals*; to this *Inconvenience* we may add another, which is, the *Difficulty* of ſeeing, diſtinctly, the little *Image* of the Sun made by a convex Glaſs, or the *Shadow*, which is very *near* the Eye; and alſo the *Horizon*, which is at a *great Diſtance* from it, at one and the *ſame Time*. Upon theſe, as well as other Accounts, it requires much *Time* and *Practice*, as well as *Judgment* and *Dexterity* in the Obſerver, to be able to manage *Davis*'s Quadrant, at Sea; whereas the *Uſe* of ours may be learned in a Quarter of an Hour, with *great Eaſe*, by a Perſon *unaccuſtomed* to make Obſervations; and the *Motion* of the Ship will give him no *Interruption*, or *Diſturbance*; for when the *Sun*, or *Star*, by ſliding the Index, is once brought to *appear* upon the *Edge* of the *Sea*, or in the ſame level Line with the *Horizon*, the *two Objects*, thus *join'd together*, will continue to be ſeen in the *ſame Situation*, without ſeparating, however it may be moved *upwards*, or *downwards*, by the *Unſteadineſs* of the Obſerver's Hand, or the *Rolling* of the Ship.

2*dly*, *Altitudes* of the *Sun*, and *Stars*, may be taken thereby, at *Sea*, more *accurately*, than with any other Inſtrument; for *Experience* teaches, that in *Obſervations* made with the *common* Quadrants, at the *ſame Time*,

Time, and on Board the *ſame Ship*, there will generally be a *Difference*, and conſequently an *Error*, of ſeveral Minutes; and not only ſo, but even in *Altitudes*, taken by the *ſame* Inſtrument, there will be a conſiderable *Diſagreement* among different Obſervers; which ſufficiently proves its *Imperfection* and *Uncertainty:* Nay farther; the Sight-Vane may be *moved* or *alter'd* ſeveral Minutes, and yet *no* Difference be diſcern'd in the Altitude by the *Shadow*; for let the moſt *skilful* Perſon about *Noon-Day*, when the Sun is *low* in the Meridian, and does not perceptibly *riſe* or *fall* for ſome Minutes of Time, as ſoon as he has *noted* the Altitude found by *Davis*'s *Quadrant*, pull off or remove the Vanes, and immediately *repeat* the Obſervation anew; and he will very *ſeldom*, unleſs by *Chance*, come within five or ſix *Minutes* of his former; as often as been *proved* by Trials, made on purpoſe to *convince* thoſe who were *bigotted* to that Inſtrument, how liable they were to *Error* even in their *beſt* Obſervations. Whereas with *ours*, every Obſerver muſt *agree* within one *Minute*; for if the Index be moved or altered *ſo much* from its right Situation; there will be an apparent *Diſtance* or *Separation* ſeen in the Teleſcope, between the Sun's Limb and the Horizon; in like manner, if the Sun *riſes* or *falls* but one Minute, it will be *diſcover'd* by this Quadrant; which beſides the *Accuracy*, leſſens the *Fatigue*, and ſhortens the *Time* taken up in making Obſervations at *Noon-Day*; by ſhewing us when the Sun has *paſs'd* the Meridian much *ſooner* than any of the *common* Inſtruments.

3dly, We are enabled hereby to find the *Latitude*, at *Sea*, much more *frequently*, than with any of the *common* Inſtruments; which is an Article of great *Uſe*, and *Importance* in Navigation; for beſides the great *Eaſe* wherewith we can take *Altitudes*, when the SUN is in or near the ZENITH, the *Quadrant* we have deſcribed, has this peculiar *Advantage*, that if the *Body* of the *Sun* is but viſible, thro' a thin *Cloud*, tho' he ſhine

ſhine not at all, or ſo *faintly*, as to give no *Shade*, yet an exact *Obſervation* may be made, and his true *Altitude* obtain'd by it; whereas *Davis*'s in that Caſe is altogether *uſeleſs*: But, we have yet a more conſiderable *Benefit* to mention, which ariſes from the *Readineſs* and *Eaſe*, wherewith we can take *Altitudes* of the *Stars*; for tho' the Sun ſhould not appear at *Noon-Day*, as too frequently happens, ſo that his *Meridian Altitude* cannot be obtain'd; yet the *Heavens* may, nevertheleſs, be *clear* and *ſerene* at ſome Time or other of the Night; and ſince at *all Hours* there will be *one* or *other* of the moſt noted of the *Fix'd Stars*, upon or near the *Meridian*, the *Opportunities* for taking *their* Altitudes, and conſequently, of finding the *Latitude at Sea*, will be almoſt as *frequent*, as can be deſired. Now to *encourage* our Navigators to make *Uſe* of the *Stars*, we aſſure them, it is as *eaſy* to take the *Altitude* of a *Star*, eſpecially in the Morning and Evening Twilights, and in Moon-light Nights, by this Inſtrument, as to find the *Height* of the *Sun*, which they will ſoon be *convinced* of, by making the *Trial*. And the *Method* of obtaining the *Latitude* thereby, is juſt the *ſame*, if the *Declination* of the *Star* be uſed, inſtead of the *Declination* of the *Sun*; and that may be readily found by the following *Table*; which, for this Purpoſe we have *rectified*, to ſerve, with a *ſufficient* Degree of *Exactneſs*, 'till the *Year* 1750.

A

A
TABLE,
SHEWING
The *Right Aſcenſion*, *Declination*, and *Magnitude*, of above 100 of the principal *Fixed Stars*, rectified ſo as to ſerve, for the Purpoſes of NAVIGATION, 'till the Year 1750.

CONSTELLATIONS and SIGNS within the ZODIACK.

	The Names of the Stars.	Bayer's Charact.	Right Aſcenſion.		Declination.			Magnitude.
			H.	M.	°	′		
ARIES	The bright Star of Aries	α	1	52½	22	12½	N	2
TAURUS	The bright Star in the Midſt of the Pleiades	η	3	32	23	16	N	3
	The Bull's Eye. *Aldebaran.* *Palilicium*	α	4	21	15	57	N	1
	In the End of the Northern Horn	β	5	10	28	21½	N	2
	In the Southern Horn	ζ	5	22	20	57½	N	3

GEMINI	In the Left Foot of the Southern Twin	γ	6	23	16	36	N	2
	In the Left Knee of the Northern Twin	ε	6	28	25	21	N	3
	The Head of the Northermoſt Twin. *Caſtor* or *Apollo*	α	7	18	32	26	N	1
	The Head of the Southermoſt Twin. *Pollux* or *Hercules*	β	7	29	28	39	N	2
CANCER	In the Hindmoſt Southern Claw	β	8	02	9	58	N	3
LEO	The Northermoſt of the Two in the Head of the Lion	μ	9	38	28	14	N	3
	The Lion's Heart. *Regulus*	α	9	54½	13	15	N	1
	The Middle of the Three in the Lion's Neck	γ	10	05	21	09	N	2
	The End of the Lion's Tail. *Deneb*	β	11	36	16	01	N	1
VIRGO	The Northern Wing of the Virgin. *Vindemiatrix*	ε	12	49	12	21	N	3
	Virgin's Spike	α	13	11½	9	47	S	1
LIBRA	The Southern Scale	α	14	36½	14	56	S	2
	The Northern Scale	β	15	03	8	24	S	2
SCORPIO	The Northermoſt of the Three in the Scorpion's Head	β	15	50½	19	04	S	2
	The Heart of the Scorpion. *Antares*	α	16	13½	25	49	S	1
	In the Tip of the Tail	λ	17	16	36	53	S	3
SAGITTARIUS	In the Southern Part of the Bow	ε	18	07	34	28	S	3
	In the Left Shoulder of the Archer	σ	18	39	26	35	S	3
	The Middle of the Three in the Head of the Archer	ο	18	49	22	06	S	3
CAPRICORNUS	The Southermoſt in the following Horn of *Capricorn*	β	20	06	15	35	S	3
	Bright Star in the Root of the Tail	δ	21	32½	17	17	S	3
AQUARIUS	In the Left Shoulder	β	21	18	6	42	S	3
	Brighter of the Two in the Right Shoulder	α	21	52½	1	36	S	3
PISCES	*Fomalhaut*	α	22	43	31	00	S	1
	In the Knot of the Strings of the Fiſhes	α	1	48½	1	29	N	3

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Constellations or Signs on the Northern Side of the ZODIACK.

	The Names of the Stars.	Bayer's Charact.	Right Aſcenſion.		Declination.			Magnitude
			H.	M.	°	′		
Andromeda	In the Head of Andromeda	α	23	55	27	38	N	2
	Southermoſt of the Three in the Girdle. *Mirach*	β	00	55	34	13	N	2
	In the Left Foot	γ	1	48	41	03	N	2
Perseus	In the Right Shoulder of Perſeus	γ	2	46	52	28	N	3
	Meduſa's Head. *Algol*	β	2	51	39	55	N	2
	In the Right Side of Perſeus	α	3	06	48	54	N	2
	In the Left Knee	ε	3	40	39	14	N	3
Auriga	In the Left Shoulder. *Capella*	α	4	57½	45	43	N	1
	In the Right Shoulder	β	5	40	44	54	N	2
Bootes	*Arcturus*	α	14	04	20	35	N	1
	Mirach in the Right Thigh	ε	14	33	28	12	N	3
	In the Head	β	14	52	41	26	N	3
	In the following Shoulder	δ	15	05	34	19	N	3
Cor. Borealis	In the Northern Crown	α	15	24	27	36	N	2
Aquila	In the Eagle's Tail	ε	18	48	14	44	N	3
	The bright Star in the Eagle's Heart	α	19	38	8	11	N	1
Pegasus	In the Right Shoulder. *Scheat*	β	22	51	26	38	N	2
	In the Left Shoulder. *Marchab*	α	22	52	13	47	N	2
	In the Wing. *Algenib*	γ	23	59½	13	43	N	2

Cassiopea	In the Chair	β	23	55½	57	43	N	3
	In the Breaſt. *Scheder*	α	00	26	55	06	N	3
	In the Leg	ε	1	36	62	22	N	3
Ursa Major	The Firſt and Southermoſt in the Square of the Great Bear	β	10	46	57	47	N	2
	The Second and Northermoſt in the Square. *Dubhe*	α	10	47	63	10	N	2
	The Third in the Square	γ	11	40	59	09	N	2
	In the Root of the Tail, the Fourth in the Square	δ	12	02½	58	31	N	2
	The Firſt of the Three in the Tail. *Alioth*	ε	12	42½	57	25	N	2
	The Second, or Middle One, in the Tail	ζ	13	11½	56	18	N	2
	The Laſt in the Tail	η	13	37½	50	38	N	2
Cor. Caroli	The Heart of K. *Charles*		12	44	39	45	N	2
Hercules	In the preceding or Right Shoulder	β	16	19	22	02	N	3
	In the Right Side	ζ	16	31½	32	05	N	3
	In the Head	α	17	03	14	42	N	3
	In the following or Left Shoulder	δ	17	04	25	09	N	3
Lyra	The bright Star in the Harp	α	18	28	38	34	N	1
Cygnus	In the Swan's Bill	β	19	20	27	30	N	3
	In the Northern Wing	δ	19	36½	44	31	N	3
	In the Breaſt	γ	20	13	39	25	N	3
	In the Tail	α	20	32½	44	22	N	2
	In the Southern Wing	ε	20	36	32	59	N	3
Cepheus	In the preceding or Right Shoulder	α	21	12	61	29	N	3
	In the Girdle	β	21	25	69	24	N	3
	In the Left or following Foot	γ	23	29	76	10	N	3
Ursa Minor	The Pole Star	α	00	40	87	54	N	3
	The Northermoſt in the preceding Side of the Square	β	14	53	75	13	N	2
Serpens	The bright Star in the Neck of the Serpent	α	15	31½	7	16	N	2
Draco	In the Head of the Dragon	γ	17	50½	51	32	N	2
Serpentarius	In the Head of Serpentarius	α	17	23	12	46	N	2

Constellations or Signs on the Southern Side of the ZODIACK.

	The Names of the Stars.	Bayer's Charact.	Right Ascention.		Declination.			Magnitude
			H.	M.	°	′		
Eridanus	The last in the River. *Achernar*	α	1	28	58	38	S	1
Cetus	In the Jaw of the Whale. *Mandibula*	α	2	48½	3	03	N	2
Orion	In the Left Foot of Orion. *Regel*	β	5	02	8	32	S	1
	The Middle of the Three in the Belt	ε	5	23	1	24	S	2
	In the Right Shoulder	α	5	41	7	19	N	1
Columba Noachi	The preceding of the two Bright Ones	1	5	31	34	15	S	2
	The following	2	5	42	35	54	S	2
Canis Major	In the Left Foot	β	6	11	17	50	S	2
	The Great Dog. *Sirius*	α	6	33½	16	21	S	1
	In the Tail	η	7	14½	28	48	S	2
Canis Minor	In the Neck of the Little Dog	β	7	13	8	48	N	3
	The Little Dog. *Procyon*	α	7	25½	5	53	N	1
Hydra	The Heart of Hydra	α	9	15	7	32	S	2
	The preceding of the Three lying in a Right Line	μ	10	13½	15	31	S	4

CRATER	In the Baſe of the Cup	α	10	47	16	54	S	3
	In the Northermoſt of the Two juſt below the Baſe	β	10	59	21	24	S	3
CORVUS	In the Bill of the Crow	α	11	55	23	15	S	3
	In the Foot of the Crow	β	12	21	21	57	S	3
CENTAURUS	*Croſiers* The preceding of the two Middlemoſt in the Croſs	ν	12	02	57	13	S	3
	Croſiers The Southern Foot of the Croſs	ζ	12	12½	61	34	S	2
	Croſiers The Northermoſt of the Four	ε	12	17	55	33	S	2
	Croſiers The following or Eaſtermoſt of the Four	ξ	12	33	58	09	S	2
	The Right Shoulder of the Centaur	θ	13	51½	35	02	S	2
	The Right Foot of the Centaur	α	14	22	59	40	S	1
PISCIS AUSTRINUS	The Mouth of the Southern Fiſh. *Fomalhaut*	α	22	43	31	00	S	1

An ESSAY *to make this* INSTRUMENT *ſerviceable at* Sea, *when there is no* Horizon *to be ſeen.*

IT often happens to be ſo *hazy* in moderate and calm Weather, that the *Horizon* is overcaſt and not to be ſeen, at Sea, for ſeveral Days together; at *ſuch* Times, if the *Latitude* could be aſcertained by *Obſervation*, within 10, 15, or even 20 Minutes, it would be extremely *uſeful*; particularly, to ſuch *Ships* as are endeavouring to make the *Engliſh Channel*, after a *long* Voyage. In order, therefore, to *adapt* this Inſtrument for ſo *beneficial* a Purpoſe, we place two *Hairs* or fine Silver *Wires*, the one *Horizontal*, the other *Vertical*, croſſing each other at *Right Angles*, in the Focus of the *Teleſcope*; likewiſe on the *Radius* BC we fix a *Level*; or elſe a *Pin* to the Backſide of the *upper Radius* AC whereon to hang a *Thread and Plummet*, that applies to a *Point* or Line mark'd under it, in the lower Radius BC; the Uſe of *each* is to RECTIFIE THE QUADRANT, or ſhew when the ſaid Radius BC lies *Horizontal*; which it muſt *nearly* do while the *Obſervation* is made, as follows;

Let any Perſon on Board, who has a ſteady Hand, hold the *Quadrant* as near as may be in the *Poſition* aforeſaid, and *ſlide* the Label along the Arch, 'till the *Sun* or *Star* is brought to appear upon the *Horizontal Hair*; pretty near its *Interſection* with the Vertical one; and the *Index* will then ſhew the *Altitude* in Degrees and Minutes; *which was required.*

In *ſtill* Weather, when the Ship has *no great* Motion, the *Author* apprehends, that an *Obſervation* may be made without much *Difficulty*, and ſufficiently *exact*; eſpecially, if ſome proper *Allowance* be made for the Unſteadineſs of the Hand; which will be known by the *Vibration* of the Object above and below the *Horizontal* Hair, when the *Index* is ſet right; and this Motion is ſo *ſlow* in the Teleſcope, that the *Quantity* of it may be *gueſs'd* at, or *eſtimated* pretty nearly by the Obſerver.

As to its *Uſefulneſs at Land*, we may venture to aſſert, that no Inſtrument will give the *Altitude* of the Sun and Stars, (or any other Angular Diſtances) with greater *Eaſe* and *Expedition* than Ours, when it is *fitted up* as we have juſt deſcribed; for,

The *Quadrant being rectified*, as above-mention'd, and the *Radius* BC remaining in an *Horizontal* Situation; the Obſerver need noly *ſlide* the Label down the Arch, till he ſees the *Image* of the Object at the *Interſection* of the two Hairs, and the *Index* then *marks* the *Altitude* required. It is therefore reaſonably hoped, the great *Facility* of obſerving with this Quadrant *on ſhore*, will induce, at leaſt the more curious among *Seafaring* Gentlemen, to determine thereby exactly the *Latitudes* of all the *Ports* and *Places* where they come; which if they would be pleaſed to impart to the *Royal Society*, or Author hereof, to make *publick*, would tend very much to their own *Advantage* and *Credit*, as well as to the *Improvement* of Geography and Navigation. *For Example*; near the Royal Hoſpital in *Greenwich*, the *greateſt* Height or *Meridian* Altitude of the Star call'd *Aldebaran*, or the *Bull's Eye*, was found in this manner to be 54°. 28′. and conſequently its Zenith Diſtance 35°. 32′. to which add the Star's *Declination* in the foregoing Table 15°. 37′. N. and we have the *Latitude* of the Place of Obſervation 51°. 29′. If the *Refraction* of the Atmoſ-

Atmoſphere at *that* Altitude be allowed for, as it ought to be, 'twill make it 35 *Seconds* more.

This QUADRANT has alſo been found of great *Service* in its *Application* to an *Azimuth Compaſs* of a new Contrivance, for determining the *Declination* of the Magnetic Needle, or the *Variation* of the Compaſs, at Sea, with greater *Eaſe*, and *Certainty*; a Thing of no ſmall *Uſe* and *Importance* in the *Art* of *Navigation*.

The *Inſtruments*, and *Methods*, hitherto uſed for this Purpoſe, (as we could eaſily demonſtrate, if it were needful,) are *ſubject* to ſeveral Inconveniencies, Errors, and Defects, which are *avoided* in this; the USE of which, take *as follows*;

1*ſt*, Let the *Index* of the Quadrant be *placed* to that Degree of the Arch, which the Obſerver *judges* to be nearly *equal* to the Height of the *Sun*, or *Star*, whoſe *Azimuth* is ſought; for by this *means* the Object will be more *readily* found.

2*dly*, Turn the *Quadrant*, and with it the *Box* of the *Compaſs* to which it is fixed, round *towards* the Sun or Star, and *ſlide* the Index a little upward, or downward, 'till the Object is *ſeen* within the Teleſcope, to *coincide* with, or *touch*, the viſible *Horizon*, which will be *ſeen* at one and the ſame Time; (the *dark-colour'd Glaſs* muſt here be interpoſed, if the Sun ſhine *too* bright.)

3*dly*, Note the *Degrees* and *Parts* of a Degree on the graduated *Circle* within the Box, mark'd by the *Needle*; and thoſe will give the *Magnetical Azimuth* of the Sun, or Star; and the *Index* of the Quadrant will alſo *ſhew* the *Altitude* of the Object; which will ever be the *ſame*, whether the Compaſs is in *Motion* or at *Reſt*.

The *Obſervation* may be very well made, in this manner, by *one* Perſon, whereas the *old* Compaſs requires the *Aſſiſtance* of *more* to manage it, at Sea.

By the *like* Method, we obtain the Sun's *Altitude*, and *Azimuth*, at one and the ſame Time, but with greater Eaſe, on *Shore*; for here, inſtead of uſing the *viſible* Horizon, we need only *rectify the Quadrant*, or place its *lower* Limb in an *Horizontal* Poſition, by means of the *Levels* fix'd upon it, for that purpoſe; and then we proceed according to the *Directions* above given, for *finding* the Sun's *Height at Land*; for when that is found, the *Needle* will ſhew the *Azimuth* as before.

How the *Variation* of the Needle from the *true Meridian*, may be found by means of the *Altitude* and Magnetical *Azimuth* thus obtained, is taught in every *Treatiſe* of *Navigation*. But as the Reſolution of this Problem is ſomewhat *troubleſome*, and depends upon *Aſtronomical* Principles; we ſhall here exhibit an eaſy *Method* of diſcovering the *Variation* of the Compaſs, at Sea, without any *ſuch* Calculation; which cannot fail of rendering this *Inſtrument* ſtill more *acceptable* to thoſe who uſe it.

1ſt, Let the *Magnetic* Azimuth of the *Sun*, or ſome *Star* when it is *near* the Prime Vertical, and conſiderably *elevated* above the Horizon, be found *before* it arrive at the Meridian, according to the Directions already given; and alſo note well the *Altitude* then obtained, or let the *Index* of the Quadrant remain fix'd at the *ſame Point* on the Arch.

2dly, Find the *Magnetic* Azimuth of the *Sun*, or the *ſame* Star, when it comes exactly to the *like* Altitude, *after* it has paſs'd the Meridian. And,

3dly, If theſe *two* Magnetical Azimuths are *equal*, the Needle has *no Variation*: If *unequal*, add them together, and *half* their *Sum* will be the *true Azimuth*; or ſubtract the leſs from the greater, and *half* the *Difference* will be the *Variation* required.

The *Circumſtances* of the Obſervation will readily *diſcover* whether the Declination is *Eaſterly*, or *Weſterly*.

N. B. Tho' it would be very *commendable* in Gentlemen who uſe the Sea, to *learn* the Names of all the principal *Fix'd Stars*, which is no difficult Taſk; yet even that Knowledge is not *neceſſary* in the laſt mention'd *Method* of uſing this *new Compaſs:* It is ſufficient, that *Care* be taken to obſerve the very *ſame Star before* it comes to the Meridian, and *after* it has paſs'd it; but for the ſake of greater *Exactneſs*, the Caution before given ſhou'd be regarded; to wit, that the *Star* be *near* the Prime Vertical, and likewiſe of a conſiderable *Altitude:* And to prevent all *Scruple*, the Obſerver may be aſſured, that an *Object*, even in the *Zenith* itſelf, is found as *readily* by this Inſtrument, as when it is but a *little elevated* above the Horizon.

FINIS.